Good Morning, I'm Bob Leheny, Director of the Microsystems Technology Office MTO).

This morning I'd like to provide an over view of MTO programs, and introduce you to the program managers who will be discussing some of our programs in greater detail.

To begin, I'd like to discuss MTO's vision in the context of our four principal technology thrusts-

* electronics,

* photonics,

* Micro Electro Mechanical Systems, or MEMS,

and what we view as the principal challenge, the integration of these technologies to create revolutionary, chip-scale Microsystems.

Chip-scale Microsystems with capabilities that can really make a difference to the war fighter.

Today, microsystems are pervasive across military platforms and the challenge is to reduce their size, weight and power requirements while enhancing or creating new functionality.

Microsystems are key enablers for Operational Dominance, insuring an Asymmetric Advantage for our forces by creating an Environment of Information Superiority,

Information Superiority means our forces are able to see further, with greater clarity, and with the ability to communicate critical information in a timely manner.

The goal of achieving information superiority translates directly to Performance Goals for Microsystems that include: having highly capable sensors, having the ability to extract useful signals from: background clutter, system noise, and intentional jamming signals having the ability to provide assured high performance communications links and having the ability to convert complex "data" into actionable "information" in near real time,

Taken together, these capabilities create a superior Information environment for "Decision making", an environment that enables our forces to "THINK" and "REACT" faster than the enemy.

MTO's programs drive information superiority by innovating new and enhanced hardware capabilities.

Consider the generic information system shown here as representative of a military platform.

I have in mind that such a platform could be: *an individual with wearable sensors and computers; *a manned or unmanned air or ground vehicle, a complex AWAC or SIGNIT platform *a city-size vessel; or the entire active theater of operation.

But, regardless of physical size, information generation and flow within such a platform relies on distinct subsystems for-

* sensing,

* processing,

* communicating

* and acting.

Sensors, designed to obtain as accurate an analog representation of the Battle Space as possible.

A/D converters, with the highest resolution and speed as possible to digitize analog data for transfer to efficient, faster signal processing modules to be transformed into actionable information.

The value of the data, and the information derived from it, and the decisions that follow, are only as good as the resources available to carry out all of these functions.

Information flow within this network is essential to accurately translate BATTLE SPACE reality into the virtual IT environment in which decision-making and action initiation occurs.

This collection of sensors, processors and communication links create a complex system.

A system designed to operate under conditions seldom encountered in commercial world applications.

And it is only through continued innovation in these enabling technologies that we can maintain information superiority for our forces.

In discussing challenges to advancing microsystem innovation, I like to refer to the flow of technology innovation illustrated here.

Experience shows that it often takes 15-20 years from the time of a scientific breakthrough until practical applications are realized.

During this period, advances are made continuously, across a wide range of problem areas.

And at each stage, a cornucopia of results is created, offering a multitude of options for the next phase of development.

The challenge is to guide development thought this maze of opportunities to achieve our objectives.

The DARPA challenge is to capture the best of this harvest of ideas early to maintain technology superiority.

Mapping specific program objectives onto this flow of technology innovation we identify programs building on material and device physics as creating Technology Push.

Technology push that leads, over 5-10 years, to new capabilities for microsystem design or functionality.

For theses programs our goal is to demonstrate improved performance, without focusing on how improved performance will ultimately displace existing approaches.

This is not to imply we're not guided by future applications, only that deliverables are not necessarily modules ready for field-testing today.

Where we can be more confident of success, we have Application Pull programs.

For these programs our goals have a shorter time horizon. Here we seek to develop and demonstrate prototype modules that can demonstrate sufficient functionality to engage system researchers interest.

In this case, deliverables are to be taken out of the laboratory and incorporated into field tests.

Recently we have accomplished just such a transition. From MTO's MEMS program to DARPA's Special Projects Office.

Building on MEMS-RF switch technology developed within our MAFET-3 program SPO has initiated a Reconfigurable Antenna program exploiting the advantage MEMS devices offer for this application.

Similar examples can be cited for all MTO programs, Examples are so common that we've introduced a section into our regular Program Reviews with the Director that we call After-Glow.

During this portion of the review, program mangers bring the Director up to date on transitions that are continuing to occur after a program's funding has ended and it is otherwise off MTO's agenda.

Now I'd like to spend a few minutes high-lighting some major program directions and results.

We begin with microelectronics.

Microelectronics is a core technology and DARPA has a long history of investments in this area.

Over the past thirty years a significant research driver for silicon microelectronics has been Moore's Law,

Moore's Law conjectures the continued shrinking of critical chip dimensions.

Progress supporting this conjecture has become so predictable that the Semiconductor Industry Association (SIA) has developed an approach to Road-Mapping the technology challenges for creating each successive generation.

And the materials and material processing research community has successfully maintained a steady stream of results supporting advances along this roadmap.

Given the predictability of this process, recent DARPA programs have looked for challenges beyond this road mapping.

For example, only a few years ago modeling predicted that scaling CMOS below 70nm would not be possible.

But our Advanced Microelectronics Program challenged this prediction.

And this past year we have successfully demonstrated devices with useful transistor characteristics and critical dimensions below 20nm, an accomplishment that will receive special recognition at this conference.

With the industry only now gearing up for the 100nm generation.

And with many problems still remaining to be addressed.

Our landmark results provide measurable milestones assuring significantly extension of the life of scaled CMOS.

The real challenge now is how to we take full advantage of the Systems-on-a-Chip capabilities a trillion-transistor chip will make possible.

Having achieved 20 nm transistors, our analysis indicates that we really are approaching hard physical limits as quantum scale effects begin to dominate performance of these otherwise classic MOS devices.

However, the insights gained from our programs leaves us confident that alternative technologies will allow for extending operation to even smaller dimensions and the possibility of exploiting new physical phenomenon.

To investigate these possibilities we are launching a group of programs exploring the nano-scale domain that lies Beyond Scaled Silicon CMOS.

These include- SMALL BANDGAP, Antimony based VERY LOW POWER III-V ELECTRONICS,

NANO-SCALE MEMS devices,

And jointly with DSO, extension of our current MOLECULAR ELECTRONICS program

In addition, addressing what may be the most challenging endeavor; are new initiatives in the Defense Science and Information Technology Offices to develop QUANTUM Electronic based communication and signal processing technology.

DARPA believes that achieving integration on this nano-scale will revolutionize the way we process information within Microsystems.

And as significant as these results will be for traditional applications we expect they will really have major impact on the emerging intersection of Bio:Info:Micro technologies.

On another front, MTO programs also continue to drive breakthroughs for very high speed, high frequency applications.

Achieving record-breaking 100GHz performance for SiGe bipolar transistors, a result that is enabling this silicon based technology to begin to encroach on applications that previously were the sole domain of compound semiconductor devices.

At the same time, progress in III-V based transistors continues with transfer of very high-speed manufacturable HBT technologies from university labs to industry.

A remaining challenge is to take advantage of this high-speed performance in applications with significant integration levels, a design challenge that we will begin to address in our new Antimony Based Compound Semiconductor and Neo-CAD programs.

We take pride in the significant pay-offs that our past investments in RF applications for III-V technologies are having in the booming commercial wireless world.

However, one negative impact of this commercialization trend has been the migration of some very talented designers and capable fabrication facilities away from DOD business to the commercial sector.

The Dot-Com phenomenon has hit home in the defense contractor community.

This is a major cause for concern, but is a topic for another venue.

Another MTO continuing success story is our investments in MEMS Technologies.

In 1992, there was little industry involvement and virtually no MEMS fabrication infrastructure anywhere in the world.

Today our significant investments are yielding revolutionary capabilities.

In addition to the widely recognized military applications for MEMS in-

* inertial sensing,
* monitoring readiness of missiles and projectiles
* fuze/safing and arming devices.,

there are the emerging applications in RF MEMs components that I've already mentioned, components that provide flexible, low insertion loss, chip-scale manipulation of high frequency signals for antenna and other signal processing applications.

And across a range of programs we continue to explore future MEMS applications including-

* MEMS enabled, chip-scale bio- microsystems,

* MEMS based uncooled high-resolution IR detector arrays,

* MEMS based agile optical beam steering and control for free space laser communication and target designation.

For these diverse applications MEMS devices are meeting new challenges-

* mixing complex on-chip fluid and mechanical components for chip-scale, pico-liter chemical processing,

* achieving high densities of very small bolometers with precision thermal management for efficient, sensitive uncooled IR sensor arrays

* and replacing bulky gimbaled optics with precise, three-dimensional laser beam positioning.

Significant remaining MEMS challenges include extending MEMS technology to nano- scale dimensions and developing on-chip power generation compatible for extending the life of MEMS remote sensors,

These are topics that we are just beginning to explore.

Finally, our photonics programs, which have been a major source for innovative technologies, and which now are having significant impact on data communication in military systems.

Beginning a decade ago DARPA investments helped create multiwavelength technologies for today's wave division multiplexed optical networks.

Joint MTO/ITO programs in this area lead to the technology base for multi-gigabit Next Generation Internet applications.

Over the same period our investments in Vertical Cavity Surface Emitting Lasers (VCELS) lead to commercialization of this unique photonics technology that today is delivering laser performance in a package that is nearly as inexpensive to manufacture as low cost Light Emitting Diodes.

We claim credit for pioneering VCSEL technology and identifying their first applications in interconnections in data networks with links spanning tens of meters down to between racks.

For these applications VCSEL technology is being transitioned to a number of service programs.

Our current program focus is successfully integrating VCSEL's with detectors and electronics to form large two- dimensional "smart-pixel" arrays and these form the basis for very high capacity, measured in tera-bits per second, back-plane and on-board chip-to-chip interconnection.

Commercial interest in applying this technology to a wide range of high performance computing applications is already building.

Future applications will mix these technologies with MEMS for hyper-spectral sensing and compact free space optical communications applications.

With five FY2000 new starts, Photonics represents a growth technology in MTO.

In the future we anticipate extending the networking versatility afforded by Wave Division Multiplexing (WDM), to seamless, and more importantly, signal format independent routing of information on all military networks.

We believe that platform scale WDM networking will be one of the next major technology breakthroughs for the application of photonics to military information systems.

Now we'll be hearing from six of the 13 MTO program managers; First, Elias Towe, will discuss the photonics programs that he, Dave Honey and Ray Balcerak are responsible for.

Christie Marian will review the microelectronics programs that he and Dan Radack manage, including details for some of our Beyond Silicon CMOS programs.

Bill Tang will review progress in MEMS technology and introduce his new programs in the MEMS area.

Abe Lee will follow with a discussion of his program on chip scale bio-sensing and processing.

Anantha Krishnan will discuss CAD for Microsystems applications and, Edgar Martinez will rap-up with a discussion of the DOD applications potential of the wide bandgap semiconductor material Gallium Nitride.

While Elias makes his way to the podium, I'd like to thank you for your attention.

I look forward to the opportunity to discuss MTO's programs with you over the next couple of days, and invite you all to visit out booth and sidebar sessions where you will have an opportunity to meet and discuss our programs and your interests in greater detail.